

Education in ‘life cycle sustainability assessment’: caring for all 3 P’s in one.

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Abstract

Starting from the observation that externalities, reflecting societal concerns, emerge from costs and benefits which are not reflected in the market price, the authors of the paper emphasize the importance in education of life cycle sustainability assessment (LCSA) as a triple-bottom line tool to assess the three dimensions of sustainable development (environment, social and economy) – often referred to as the inclusive 3 P’s-approach (planet, people and profit) – of products, from cradle to grave.

Especially the social LCA, as part of the overarching LCSA, has been developed to identify and to assess the social conditions throughout the life cycle of a product in order to improve human well-being. The concept of ‘social justice’ and its operationalization form the background for the development of different stakeholder categories, subcategories and indicators to undertake the social and socio-economic assessment.

Two international publications (Benoît and Mazijn, 2009; Valdivia et al., 2011) are used during teaching and training session to give an overview of the social LCA and the LCSA. These guidance for the assessment of products resulted from inter- and multidisciplinary work. It was developed with the support of the authors, who have all an engineering background, but who worked for ten years now together, inter alia, with experts from social sciences.

Different training sessions have been set up and LCSA (incl. social LCA) has been part of courses at universities, all with multiple objectives of a learning curve for engineering education within the context of sustainable development. Based on that experience in different countries, the authors are formulating recommendations for future educational material.

Looking back at the Declaration of Barcelona (EESD 2004) and comparing with the objectives of the formal and non-formal education on LCSA, the authors claim that LCSA (and the on-going research) provides an excellent opportunity to fulfil the requirements of Engineering Education for Sustainable Development. Answering the question ‘What is a sustainable product?’ by using LCSA is learning to deal with complexity and uncertainty across the boundaries of a diversity of disciplines.

1 About societal concerns and externalities

The reason for societal concerns about the social, environmental and economic impacts is because of the externalities of “activities that affect the well-being of people or damage the environment, where those impacts are not reflected in market prices. The costs (or benefits) associated with externalities do not enter standard cost accounting schemes.” (Valdivia *et al.*, 2011). Note that making a distinction between the three dimensions of sustainable development (environment, economy and society) is often referred to as the ‘triple bottom line’-concept (Elkington, 1997), a concept which can be seen as similar to the inclusive 3 P’s-approach: people, planet and profit.¹ Figure 1 shows a matrix illustrating the distinction between private costs and benefits, and externalities and is reflecting what is at stake when assessing goods or services within the context of sustainable development.^{2, 3}

	Planet	People	Profit/Prosperity
Externalities (costs or benefits)			
Private costs or benefits			

Figure 1: The 3 P’s: private costs and benefits versus externalities.

The blue line in Figure 1 delimits the private costs and benefits reflected in the market price. Sometimes external relevant costs and benefits anticipated to be privatized, such as increasing prices of CO₂-emissions, are taken into account in monetary terms: see red line. However it is illusory to consider all externalities, within the limits of the green line, in the costs of goods and services produced by the value chain.⁴ Therefore other indicators to reflect social, environmental and economic impacts – ‘in consistency with international norms of behaviour’ (cf. the definition on ‘social responsibility’ of ISO 26000) - are needed to assess - from cradle to grave - the life cycle of products.

¹ However, since people and planet imply a collective interest, profit can be interpreted as private interest. Therefore, it is not surprising that the World Summit on Sustainable Development (Johannesburg, 2002) referred instead to ‘people, planet and prosperity’.

² Note that the paper is about learning to assess ‘goods and services’. It is obvious that societal concerns are not always necessarily linked to costs. For example, ‘you must not murder’ is a rule where we can assume that it expresses societal concerns, but for which it is not necessary to figure out the external costs of murder to operationalize this rule. Likewise, a good, healthy natural environment can be seen as a goal that is desirable, even if it is not possible to put external costs to it.

³ The definition of is not reiterated once again. The authors refer to the definition and interpretation given by the World Commission on Environment and Development (1987).

⁴ The reason for stating this is related to the problems of having a scientific method of calculating the price at each stage of the value chain, being accepted by all stakeholders.

2 Linking all 3 P's with the life cycle of products

The development of 'life cycle assessment' (LCA) resulted initially in the publication of a LCA Code of Practice (Consoli F. *et al.*, 1993), followed by the development of four ISO standards (ISO 14040-14043) published in the years 1997-2000, all of which were replaced in 2006 by two standards, ISO 14040 and ISO 14044. These standards describe the requirements and formulate recommendations for elaborating a LCA. At first it was meant to address the environmental aspects of a product and their potential impacts throughout that product's life cycle. Courses and training modules have been set up all over the world for almost twenty years.

However, the picture of a 'sustainable' product is not complete unless impacts on all actors along the life cycle, including workers, local communities, consumers and society, are analysed. Recognizing the need for the integration of social and socio-economic criteria into LCA, in 2004 the UNEP/SETAC Life Cycle Initiative⁵ established an international Task Force "*to convert the current environmental tool LCA into a triple-bottom-line sustainable development tool*". By 2009 the 'Guidelines for social life cycle assessment of products' (Benoît & Mazijn, 2009) were published with a set of (sub-)categories capturing societal concerns. The subtitle of the publication is relevant within this context: 'Social and socio-economic LCA guidelines complementing environmental LCA and Life Cycle Costing, contributing to the full assessment of goods and services within the context of sustainable development.' Indeed, LCC or Life Cycle Costing is regarded as the third LCA technique aiming at "*The assessment of all costs associated with the life cycle of a product that are directly covered by 1 or more actors in the product life cycle (supplier, manufacturer, user or consumer, and/or End of Life actor), with the inclusion of externalities that are anticipated to be internalized in the decision-relevant future.*" (Hunkeler *et al.*, 2008).

These different life cycle assessment techniques can be combined as part of an over-arching 'life cycle sustainability assessment' (LCSA) and allow to assess the impacts of the value chain. Lately the methodology has been presented in two publications (Valdivia *et al.*, 2011; Valdivia *et al.*, 2012) where it has been emphasised that LCSA ...

- *"helps to organise complex environmental, economic and social data in a structured form;*
- *clarify the trade-offs between the three sustainability dimensions, life cycle stages and impacts;*
- *provide guiding principles to achieve sustainable production while stimulating innovation ...;*
- *help to raise credibility by communicating useful quantitative and qualitative information about their products and process performances ...;*
- *and show how to become more responsible by taking into account the full spectrum of impacts associated with their products and services."*

It is interesting to note that (methodological) developments around 'life cycle thinking' were not limited to present tools for analysis or assessment. In fact, LCSA can be regarded as part of the Deming wheel – the well-known PDCA-cycle⁶ - where the 'assessment' correspond clearly with

⁵ See www.lifecycleinitiative.org (last accessed July 2013).

⁶ PDCA stands for 'Plan, Do, Check, Act' in which 'Check' is sometimes replaced by 'Study' and 'Act' by 'Adjust'.

the ‘check’ and should be followed by action (before a renewed planning is set up).⁷ This is all about management, i.e. ‘life cycle management’, which is another important area of work in the LCA-field over the last twenty years (Remmen *et al.*, 2007).

All in all, it is clear that LCSA is important to be covered whenever an engineer manages the development of a product or manages any process. It is about anticipating the expectations on sustainable development, incl. social considerations, of the society.⁸

3 ‘Social justice’: the reference for social considerations

There is a longstanding discussion on ‘social justice’. It originated in religious traditions, but ‘social justice’ as a secular concept emerged mainly in the late twentieth century, influenced in the first place by *A Theory of Justice* (Rawls, 1971) publishing a theory known as ‘Justice as Fairness’, from which he derives two principles of justice: the liberty principle and the difference principle. The point of view of Rawls, in particular the two principles, has been criticized over the past decades by different authors. Responding to the criticisms John Rawls published in 2001 *Justice as Fairness: A Restatement* in which he reformulated the two principles as follows:

- each person is to have an equal right to the most extensive total system of equal basic liberties compatible with a similar system of liberty for all;
- social and economic inequalities are to be arranged so that they are both: a) to the greatest benefit of the least advantaged, and b) attached to offices and positions open to all under conditions of fair equality of opportunity.

Over the past decades the essence of these principles has been translated into international agreements (conventions, treaties, etc.). The mandate of the International Labour Organisation e.g., as set out in the Preamble to its Constitution, opens as follows: “...*universal and lasting peace can be established only if it is based upon social justice ...*”. The operationalization can be found in the identification by the ILO's Governing Body of eight conventions earmarked as ‘fundamental’, covering subjects that are considered as fundamental principles and rights at work. Other international agreements and conventions, e.g. on Human Rights and Workers Rights, made the link as well.

More recently, the World Day of Social Justice was proclaimed on 20 February by the United Nations General Assembly (2007) and it “*encourages Member States to promote national activities that support efforts to eradicate poverty, promote full employment and decent work, gender equity and access to social well-being and justice for all.*” Secretary-General Ban Ki-moon stressed this year “*the need for policies that promote inclusive development, adding that only by addressing inequality can countries achieve social justice.*”⁹ He added “*As we seek to build the world we want, let us intensify our efforts to achieve a more inclusive, equitable and sustainable development path built on dialogue, transparency and social justice.*”

⁷ Note that that life cycle approaches might be used as well in ‘Plan’ phase of PDCA, for instance, in establishing the significant aspects and impacts.

⁸ LCSA (as well as social LCA) has been applied in practice; see e.g. Ciroth and Franze (2011) and Capitano *et al.* (2011).

⁹ See <http://www.un.org/apps/news/story.asp?NewsID=44181> (last accessed in July 2013)

In addition, it is also worth mentioning the ‘social contract theory’ which is sometimes perceived as a theoretical ground for – inter alia – the social responsibility of organisations (incl. enterprises). It is the view that people’s moral and/or political obligations are dependent upon a contract or agreement between them to form society. The same John Rawls offers in his book *Theory of Justice* (1971) a perspective on this theory. *“Furthermore, the notion of transparency (or the need for an organization to provide information and report on non-financial aspects), the notion of accountability (responsibility and liability), advancements on corporate governance (decision making processes, consistent management and cohesive policies) and, in the context of globalization, corporate citizenship (the notion that enterprises must not only be engaged with stakeholders but be stakeholders themselves alongside governments and civil society) are contributing to shape current definitions of ‘social responsibility’.”* (Benoît and Mazijn, 2009).

It is against this background that the social LCA technique, as part of the overarching LCSA, has been developed and serves as a tool to identify and assess the social conditions throughout the life cycle of a product in order to improve human well-being.

4 A social LCA, a part of LCSA

The social LCA (S-LCA), as a part of the overarching LCSA, is an impact (and potential impact) assessment technique that aims to assess the social and socio-economic aspects of products and their potential positive and negative impacts along their life cycle, from ‘cradle to grave’.¹⁰ The different aspects assessed in a S-LCA are those that may directly affect stakeholders positively or negatively during the life cycle of a product. They may be linked to the behaviours of enterprises, to socio-economic processes, or to impacts on social capital. Depending on the scope of the study, indirect impacts on stakeholders may also be considered. Five main stakeholder categories have been identified (workers/employees; local community; society; consumers and value chain actors), each of which can be regarded as a cluster that have shared interests due to their similar relationship to the investigated product systems (Benoît & Mazijn, 2009). Additional categories of stakeholders or further differentiations or subgroups can be added when undertaking the assessment. The stakeholder categories provide a comprehensive basis for the articulation of the subcategories. Furthermore, it should be emphasized that social and socio-economic subcategories have been defined according to international agreements such as the ILO-conventions (see above). Other developments at the international level, inter alia on ‘social responsibility of organisations’, have been taken into account as well.

It is within this context that a comprehensive set of subcategories is presented in the table below. Each subcategory may be measured using different inventory indicators, for which methodological sheets have been developed.¹¹

¹⁰ Within this context (see below), it is important to note: *“The product utility is required to be described in functional terms, both in E-LCA and S-LCA. S-LCA goes further by also requiring that practitioners consider the social impacts of the product use phase and function.”* (Benoît and Mazijn, 2009).

¹¹ A standard layout for methodological sheets has been used, including fields such as definition, policy relevance, assessment of data, source examples, analysis methods, references.

Table 1: Stakeholder categories and subcategories for a social LCA.

Stakeholder categories	Subcategories
Stakeholder ‘worker’	Freedom of Association and Collective Bargaining Child Labour Fair Salary Working Hours Forced Labour Equal opportunities/Discrimination Health and Safety Social Benefits/Social Security
Stakeholder ‘consumer’	Health & Safety Feedback Mechanism Consumer Privacy Transparency End of life responsibility
Stakeholder ‘local community’	Access to material resources Access to immaterial resources Delocalization and Migration Cultural Heritage Safe & healthy living conditions Respect of indigenous rights Community engagement Local employment Secure living conditions
Stakeholder ‘society’	Public commitments to sustainability issues Contribution to economic development Prevention & mitigation of armed conflicts Technology development Corruption
Value chain actors (not including consumers)	Fair competition Promoting social responsibility Supplier relationships Respect of intellectual property rights

Subcategories are the basis of a social LCA and therefore they are the items on which justification of inclusion or exclusion needs to be provided. The subcategories are socially relevant themes or attributes. Subcategories are classified according to stakeholder and impact categories and are assessed by the use of inventory indicators. Several inventory indicators and units of measurement/reporting types may be used to assess each of the subcategories. Inventory indicators and units of measurement may vary depending of the context of the study. The ultimate objective is to translate this result into major impact categories of human well-being.

Different contexts will represent different challenges and will need varying levels of assessment. For example, the legislation in developed countries may already cover many Human Rights and Worker Rights indicators and the application of the law may be put in place; this might not be the case in a developing country. International standards tend to define floors rather than ceilings. However, it is important to emphasize that this should not be taken for granted. A hotspot-analysis can help to undertake a first screening, e.g. by use of the ‘Social Hotspots

Database’ which is publishing country-specific sector risk results to direct attention to those social issues that are in need of enhanced engagement.¹²

5 EESD, inter alia about incorporating social sciences and humanities

The reference for Engineering Education for Sustainable Development is the Declaration of Barcelona¹³ adopted at EESD 2004. Almost 10 years later it is still relevant. Within the context of this paper the following points of the declaration should be highlighted.

The preamble underlines the challenges to achieve “*a more just society based on respect for nature and human rights, and demands a fairer economy and greater solidarity towards different cultures and future generations.*” The declaration itself describes the (future) abilities of an engineer, the way engineering education and the educational process is organised. “*Incorporate disciplines of the social sciences and humanities.*” is one of the 8 goals of organising engineering education.

It seems little progress has been made at universities, including inter alia engineering faculties, over the last ten years to cope with the cited challenges by stimulating interdisciplinarity and setting up multidisciplinary teams.¹⁴ One of the main reasons is that disciplinary ‘silos’ (faculties, departments ...) at universities are not a stimulating environment for communicating with experts who speak different ‘languages’.

This observation has recently been highlighted again. A guide for student sustainability educators was published by the World Wildlife Federation and the Association for the Advancement of Sustainability in Higher Education (Erickson, 2012). One of the listed action items deals with ‘collaborating’: “*Collaboration with other departments and programs on campus ... incorporate concepts such as social justice that are often neglected in sustainability education ...*” Koppelman (2013) reviewed the guide, points to the conclusions of other authors (Edwards, 2012; Kerr and Hart-Steffes, 2012) and is asking himself “*Are We Really Educating about Sustainability?*” He argues in severe terms “*that more attention is needed on the economic and social dimensions of sustainability*”, explicitly mentioning ‘social justice’.

Based on their own teaching and training experiences, the authors of this paper, all with an engineering background, do subscribe these findings. It can be recognised that some progress has been made during the last couple of years to pay attention to the social dimension of sustainable development into engineering education (Valdes-Vasquez, 2011; Sinnott and Thomas, 2012) but the focus lays in the first place on product utility (see footnote 10) and the management approach (CSR, OHS ...). Social considerations along the value chain/life cycle of a product, against the background of social justice, are not structural embedded in engineering education and made clear to the students in all its (relevant) details. It can be expressed as follows: if nowadays a module is available for teaching or training, it is thanks to the coincidence of engaged people being in a position to do so and not because universities,

¹² See <http://socialhotspot.org/> (last accessed in July 2013).

¹³ See <http://www-eesd13.eng.cam.ac.uk/conference/barcelona> (last accessed in July 2013).

¹⁴ Note that within this context ‘interdisciplinarity’ goes beyond working together in a team of people all with background of natural sciences but coming from different (sub-)disciplines. Here, it is about setting up interaction between engineering and social sciences.

colleges ... have been incorporating that part of the Barcelona Declaration in a systematic and coherent manner.

* * * * *

After an interactive process of 5 years, researchers from different disciplines (with a background of engineer, anthropologist, social scientist, economist, political scientist ...) in the UNEP Task Force (see above) succeeded to come forward with a peer reviewed tool: a social LCA based on the ISO 14040 and 14044 complementing the environmental LCA and LCC. Later on, a similar multidisciplinary group worked together to bring an integrated approach to the fore: *“While methods for (environmental) LCA, LCC and social LCA have been developed as stand-alone techniques, their combination in one study allows for integrated decision-making on the triple bottom line of sustainable development: people, planet and profit.”* (Valdivia et al., 2011).

* * * * *

The authors of this paper, working now for many years together, are well aware that a standalone publication with guidance to undertake a LCSA is not sufficient. In line with Chapter 35 – Science for Sustainable Development and Chapter 36 – Promoting Education, Public Awareness and Training of Agenda 21 underlining the importance of interdisciplinary research and education as well as building capacity and capability, the 2009 publication it was stressed e.g. that there is a need ‘to produce educational material’ which *“...will become necessary to effectively communicate the best practices in S-LCA to students and persons willing to undertake S-LCA studies.”* At first educational material was developed for S-LCA, later on expanded to LCSA.

Different training sessions have been set up (Belgium, Brazil, Chile, France, Germany, Canada, United States, Israel, Sweden ...) ¹⁵ and LCSA (incl. social LCA) has been part of courses at universities (Ghent University -Belgium, Federal University of Technology of Paraná – Brazil, University of New Hampshire – United States ...).

The objectives of this formal and non-formal education are multiple and can be summarised as follows: ¹⁶

- understanding of the background and the need of LCSA;
- understanding the differences between different instruments of ‘social responsibility’;
- understanding of the three techniques, incl. complementarities and differences;
- understanding of the different supporting tools for LCSA; ¹⁷
- understanding of the applications of LCSA and its limitations;
- ability to analyse and/or report the results of a LCSA within a broader context.

Detailed programmes of training sessions and courses are available upon request.

¹⁵ E.g. Sustainability and Social LCA international training course by Greendelta (Berlin, 2012) and Practical issues in Life Cycle Sustainability Assessment - Life Cycle Sustainability Training and Interactive Workshop by Greendelta, UNEP/SETAC Life Cycle Initiative and Chalmers University (Gothenburg, 2013).

¹⁶ Note that e.g. a one day training does not allow to work towards an *in-depth* understanding. Therefore a course of e.g. 5 ECTS is needed.

¹⁷ ‘Expert needs experts’: expertise in applying a LCSA (three techniques!) does mean that you need rely on specific expertise of other disciplines such as stakeholder theory, monitoring, multi-criteria analysis, impact assessment, database development, etc.

From their education experience, incl. the interaction with students/participants, the authors of this paper can put to the front the following points:

- participants in training sessions and students at universities are interested to learn, preferably in an inter- and multidisciplinary setting, about all dimensions of sustainable development through a tool for evaluating the sustainability of products and their global value chains;
- more examples from practice are needed to be used in the educational material, inter alia to make problem-based learning more in line with the specific curricula;
- in engineering education students are learning to deal with other types of problems such as qualitative versus quantitative monitoring and evaluation;
- there is difference of learning with regard to the maturity of participants/students and the duration of the training/teaching: educational material should be adapted accordingly;
- a specific follow-up instrument for evaluating the training/teaching by the participants/students should be developed.

Within the broader context of education, the authors of this paper do see a course on LCSA as a mean to challenge the current paradigm shift as described by Nussbaum (2010) from an education oriented on ‘human development’ towards a limited scope of ‘economic growth’. Learning to care for all 3 P’s, against the background of (social) justice, from cradle-to-grave, in one assessment tool helps students to reflect on what is going on beyond their own world.

6 Conclusion

As explained by Rietje Van Dam-Mieras (2012), the last two decades *research* and *higher education* have been interrelated – but in a way separated - processes, e.g. in Europe through the Lisbon Strategy for Growth and Jobs and the Bologna Process. The objective of the Lisbon agenda is to ensure Europe's prosperity and growth through a competitive knowledge economy. The Bologna process aims to harmonize policies in the field of European higher education and the creation of a European Higher Education Area. In the future there is a need to power higher education from state-of-the-art basic and applied research in order to contribute to the society. In short, there was until recently a rather strong self-Europe-focused agenda in the field of higher (and on preparatory) education.

Furthermore she explains that ‘education *for* sustainable development’ means that the focus is not only on awareness but as well on the deployment of individual talent so that he or she can contribute to sustainable development from their own talent and specialization. This means learning in a learning environment where it is perceived that the process of knowledge development is not always linear. Knowledge needs to deal with the complexity and uncertainty of social change.

The authors of this paper claim that education on LCSA and the on-going research provides an excellent opportunity to fulfil the requirements as described above. Looking for an answer on the question ‘What is a sustainable product?’ by using LCSA is learning to deal with complexity and uncertainty across the boundaries of a diversity of disciplines in a globalised world.

Furthermore, during education it can be emphasized that LCSA can in fact be part of the well-known PDCA-cycle and link it to ‘life cycle management’ leading to continual improvement.

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